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COMPUTER-BASED TRAINING OF RECIPE CONVERSION WITH LOWER APTITUD--ETC(U)
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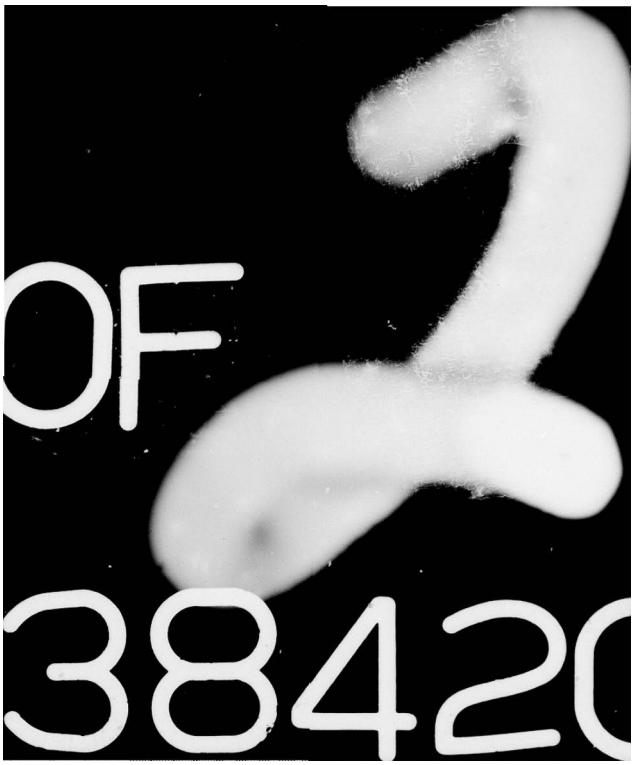
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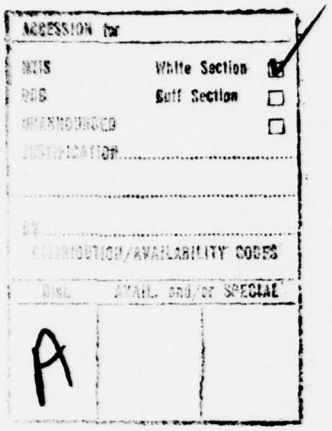

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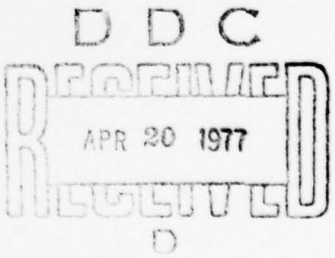

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The study tested the feasibility of computer-based training (CBT) for students with below average academic skills and evaluated a job performance aid used in recipe conversion for the Mess Management Specialist School. There were 20 students in each of 3 groups: two CBT experimental groups and a control group. One CBT group received the job aid and the other, the traditional math as taught in the school but on-line. The →

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control group received classroom training from an instructor using traditional math. The CBT groups required significantly less training time than the control group (4.4 hours vs. 26.5 hours) while maintaining high scores on the final test which was criterion-referenced. However, the CBT job aid group performed significantly poorer than the no job aid and classroom groups. The student questionnaire indicated that the typical student gave a high rating to the CBT instruction. It is suggested that individualized CBT is efficient in terms of reduced training time.

FOREWORD

The work described in this report was completed under Advanced Development project Z0108-PN (Education and Training Development), Subproject Z0108-PN.30A (Adaptive Experimental Approach to Instructional Design). Hardware communications costs were supported by the Advanced Research Projects Agency, Cybernetics Technology Office.

The cooperation of members of the Food Service School Command, especially that of MSC A. F. Whittenburg, is gratefully acknowledged. Dr. Richard E. Hurlock, Mr. Robert Harrigan, Dr. Dewey Slough, and Mr. George Lahey have all contributed greatly to this study.

J. J. CLARKIN
Commanding Officer

SUMMARY

Problem

Although computer-based training (CBT) techniques have been shown to be effective, they have been applied mostly to trainees average and above average in academic aptitude. Thus, there was a need to develop effective teaching techniques for below average trainees and for special curriculum areas in which there are training problems.

Objective

The goals of the study were (1) to determine the feasibility of computer-based training (CBT) for students with below average academic skills, (2) to evaluate the benefit of a job performance aid designed to facilitate efficient task performance and reduce training requirements, and (3) to assess the attitude of students toward CBT.

Approach

A total of 60 students from the Mess Management Specialist Class "A" School participated in the study. This school was selected because students do not have to meet stringent entrance requirements. The students utilized were in their second week of a heavily math-oriented course on recipe conversion, in which 50 percent of the students scored below 75 percent on the area final examination and performed poorly in the lab situation. The students were divided into three groups: two CBT experimental groups and a control group. The control group received traditional training, which consisted of 1 week of classroom lectures. The experimental groups received self-paced individualized CBT materials presented in a learner control mode. One CBT group was taught recipe conversion using mathematical solutions, and the second, using a job aid designed to decrease errors and to reduce time required to adjust a recipe. On completion of training, CBT groups completed an attitude questionnaire. The final test for all groups consisted of actual recipe conversion problems.

Findings

1. CBT resulted in significantly reducing training time (about 4.4 hours versus 26.5 for classroom instruction). All groups scored high on the final test, although the Job Aid group ($\bar{X}$ = 88) scored significantly lower than the No Job Aid group ($\bar{X}$ = 94) and the classroom group ($\bar{X}$ = 95).

2. The job aid used in the experimental treatment did not produce the expected savings in training time or reduction of recipe conversion errors.

3. The student questionnaire indicated that students adapted well to learner control and rated CBT as an "outstanding" model of instruction.

Conclusions

The data strongly suggest that self-paced individualized CBT can be a useful instructional methodology for low aptitude trainees. Training time is shortened without degrading performance compared to traditional classroom instruction. However, if CBT is to be applied in the Mess Management Specialist curriculum, a method is needed to coordinate this flexibility in training time with the realities of the lab (galley) situation.

Recommendations

1. Use of the job aid should be taught separately from theory on recipe conversion.

2. The CBT lesson developed using mathematical solutions should be used as a math remedial tool by the MS school.

CONTENTS

INTRODUCTION

Problem

A goal of Navy training is to minimize training time while maintaining or enhancing performance. This goal has typically been accomplished by providing individualized or self-paced instruction through application of computer-based training (CBT). However, in the past, CBT techniques have been applied primarily to highly technical Navy "A" schools (i.e., electronics), which use stringent procedures in selecting trainees (Ford, Slough, & Hurlock, 1972). Thus, there was a need to develop effective teaching techniques for below average trainees and for special curriculum areas in which there are training problems.

Purpose

The primary objective of this study was to determine the feasibility of CBT for students with below average academic skills, as evidenced by scores obtained on the Navy Basic Test Battery. A secondary objective was to evaluate the use of job aids, because they had been considered quite important in the instruction of lower aptitude personnel (Main, Harrigan, & Hooprich, 1971). These job aids were originally developed for the Commissaryman/Steward ratings, which have since been combined to form the Mess Management Specialist (MS) rating. No experimental evaluation was made of these job aids at the time of their development.

Finally, this study attempted to assess student attitudes in regard to CBT technology, sometimes referred to as computer-aided instruction (CAI). There has been some research (Cole, 1971) indicating that "under-educated" adults react negatively to such instruction. Cole found that subjects in his study were not able to handle the complexities of the IBM 1500 system student terminal. Students felt that the response modes were too complicated and were upset by the random delays and frequent system failures. In a follow-up questionnaire, they indicated that they did not like the system and that an hour of CAI a day was the maximum desired. Cole concluded that a smooth running system was needed to eliminate negative student response. In contrast, NAVPERSRANDCEN studies on the IBM 1500 system with higher ability students found that most students preferred CAI over classroom instruction, scored higher on tests, and trained 45 percent faster than classroom controls (Ford, Slough, & Hurlock, 1972).

METHOD

Subjects

A total of 60 Navy trainees at the Mess Management Specialist (MS) Class "A" School, Naval Training Center, San Diego were randomly selected over a 10-week testing period to participate in the study. Although eligibility for training in "A" schools normally is partially dependent on scores obtained on the Navy Basic Test Battery (e.g., GCT and ARI), MS schools have no formal cutoff score for admittance. As a result, the academic skills of MS students may vary considerably.

The MS course runs for approximately 8 weeks. The students selected were in their second week, and were being instructed in the math-oriented recipe conversion area. This task involves changing a standard recipe for 100 servings to accommodate different numbers of servings while maintaining the relative proportions of the ingredients. Experience has shown that recipe conversion is an area in which trainees experience consistent learning difficulties and instructors report the most pedagogical problems. To illustrate, at the time this study commenced, records indicated that at least half of MS students were scoring below 75 percent on the area final examination and also were performing poorly in the laboratory situation (galley), which is the real criterion measure for the school.

Experimental Design

The subjects were divided into three groups of 20 students each--two experimental groups, to receive computer-based training (CBT), and a control group, to recieve traditional instructor-classroom training. One CBT group was to use the conventional long-hand math solution approach; and the other, job performance aids, as represented with computer graphics and a hard copy of the job aid.[1] It was expected that job aids would not only decrease the time required to solve recipe conversion problems but also reduce errors.

Table 1, gives mean GCT and ARI test scores for each group. The school has no formal cutoff score for admittance and there is a wide range of combined GCT and ARI scores. Over 35 percent of the students scored below the generally accepted minimum of 100. The subjects therefore represented a population of students with average/below average academic skills, at least as compared to electronics students, whose GCT + ARI scores average about 120 (Lahey, Hurlock, & McCann, 1973).

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[1]Original plans were to present the job aid cards using a microfiche slide selector rather than by graphics displays. Accordingly, photos were taken of artwork representing the job aid cards, which used the largest letters possible and various colored backgrounds, while still maintaining the required detail. However, when the microfiche was projected on a plasma tube with black background, the numbers were not legible because there was not enough contrast.

Table 1

Means and Standard Deviations for Background Scores by Group

	CBT-- Job Aid		CBT-- No Job Aid		Control	
Test	Mean	SD	Mean	SD	Mean	SD
GCT	53.9	7.53	52.6	6.31	52.2	5.45
ARI	50.65	4.46	51.5	6.2	52.35	6.58

Hardware

The two individualized courses on recipe conversion were presented via PLATO IV, an instructional time-sharing system. Student terminals in San Diego were connected to a CDC Cyber 73 computer at the University of Illinois/ Urbana by voice-grade telephone lines. The terminals consist of a plasma display panel with a keyboard and touch panel interface. Stifle (1970, 1971) presents a more detailed description of the PLATO IV system and terminal.

Lesson Material

All the recipes used in the services are contained on Armed Forces Recipe Service (AFRS) cards and based on a standard of 100 portions. These recipes must be adjusted to accommodate different numbers of servings; the numbers of people served per meal changes routinely, requiring either an increase or decrease in quantities of food prepared. Also, they are sometimes adjusted to use up surplus amounts of food. The adjustment of the recipe to meet these needs is called recipe conversion.

The computer-assisted instruction (CAI) lessons for the two experimental groups implemented an early version of a learner control "driver" lesson, which was developed for the PLATO IV system (Lahey, Crawford, & Hurlock, 1976) and patterned after strategies employed by Merrill (1973). Although the learner control driver has the course strategy "designed-in" as an integral part of the system, the exact course content must be added by the author. Under the learner control theory, the student may choose his own approach to control of lesson strategy.

Lahey, Hurlock, and McCann (1973), in their study on CBT using electronics students, demonstrated that these students learned as well in a learner control situation as they did in a program control situation where a pretest determined the learning sequence. Fredericks (1976), in a related

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study, found that a student control group performed significantly faster than a program control group. Their test scores were also higher than those of the program control group, but the difference was not significant.

It should be noted that learner control may involve different procedures in different studies. For example, in the Lahey, et al. study, the student had only sequence control. That is, he was free to choose the sequence of the objectives he wanted to study from a list of course objectives. However, once he had made this decision, he was led through a tutorial sequence. In Fredericks' (1976) study, students had some control over the amount of training recieved. In the present effort, CBT students were allowed both sequence and strategy control; that is, they could choose the sequence, difficulty level (easy, medium, hard), the type of presentation (rule, example, practice), and the quantity desired. Figure 1 shows an example of a practice problem on line.

As indicated previously, the CAI lessons were designed to teach two different methods of adjusting recipes. One lesson--for the No Job Aid (NJA) group--was an individualized version of the traditional long-hand math approach now used in the MS school. The other--for the Job Aid (JA) group--presented recipe adjustment solutions using a job aid presented on line and off line, which had previously been designed to reduce training requirements and optimize task performance. At the top of Figure 1 is a graphical example of one job aid card used in conversion.

Figure 2 shows the training index used for the no job-aid version of the CBT. This index is the initial contact the student has with the lesson material, following an introductory unit that familiarizes him with the keyboard and special keys required to enable him to move between presentation modes.

Procedure

During the first day of the recipe conversion class, the actual measuring equipment was introduced and demonstrated. Examples of the AFRS recipe cards were distributed, and the card format was explained in detail. At the beginning of the second day, the 40 students assigned to the experimental groups were told to report to the PLATO/CAI laboratory. The 20 students in the control group remained in the classroom and continued their studies.

When the CAI students arrived in the PLATO lab, the proctor gave them a presentation describing the goals of the project and randomly assigned them identification numbers that determined which version of the CAI lessons they were to receive, introduced them to the terminal keyboard, and taught them how to use the special keys required for operating within the learner control format. The appropriate CAI lesson material was initiated when the student indicated his desire to begin. After he had finished the lesson, he completed an attitude questionnaire, followed by an alternate form of the school final test, which completed the CBT lab portion of the study. Students were then allowed to return to the classroom. The final test--for all groups--consisted of actual recipe conversion problems.

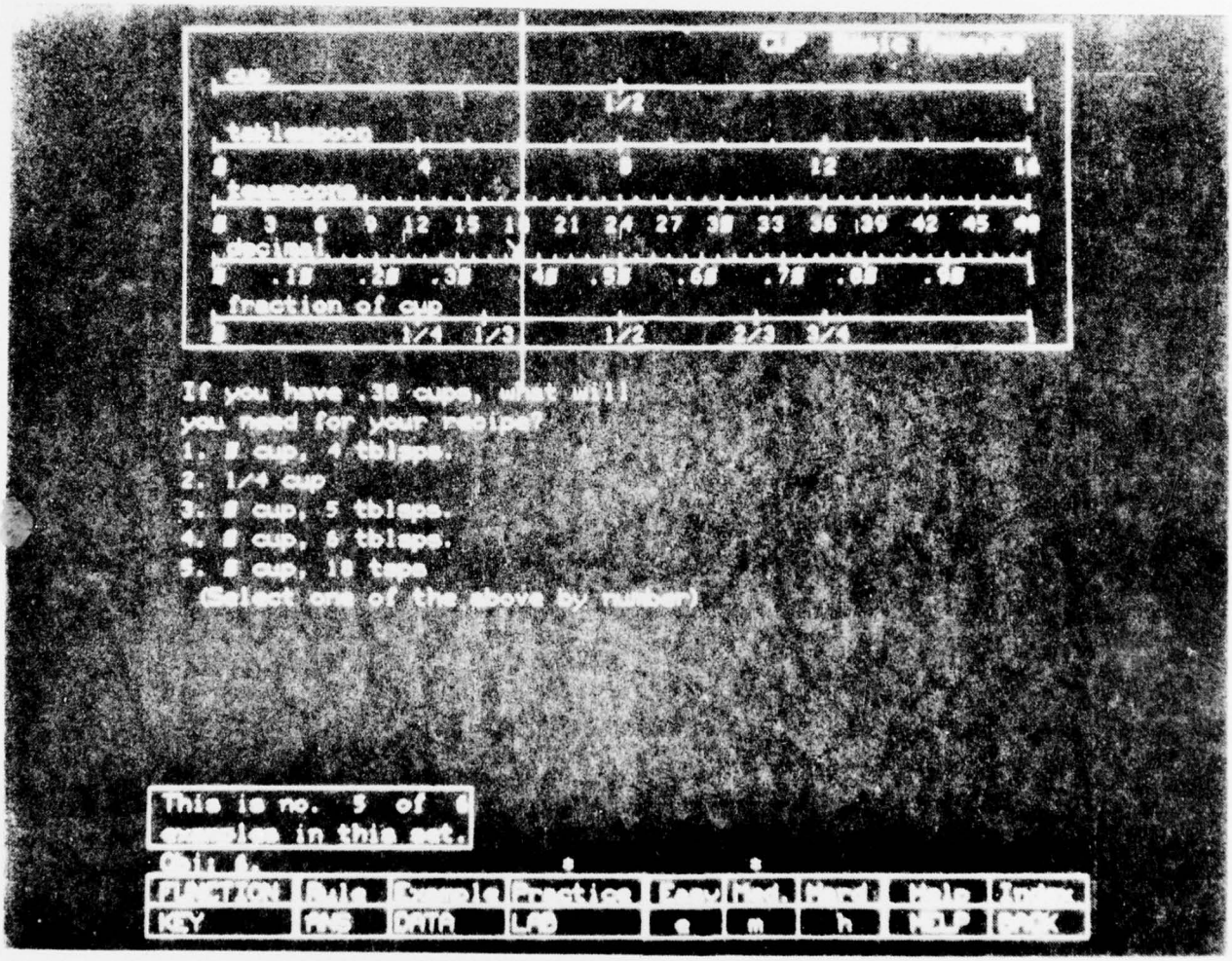

Figure 1. Example of a practice problem in recipe conversion.

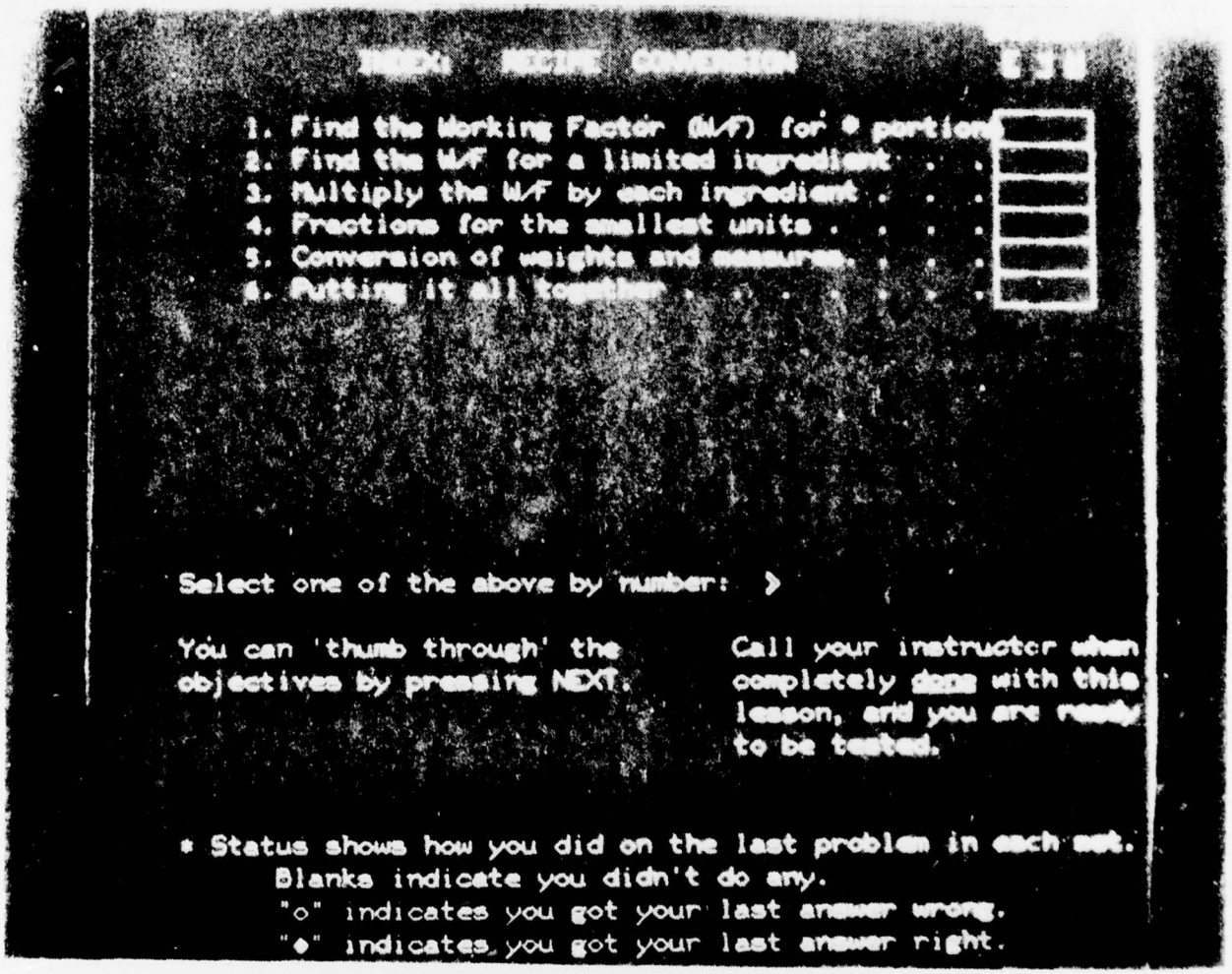

Figure 2. Training Index for the no job-aid version of the CBT.

RESULTS

Comparison of CAI and Control Groups

Table 2, which compares the training time required and final test scores obtained by the three groups, shows that the two CBT groups required less than one-fifth the training time required by the control group. This was highly significant for both CBT groups ($t = 56.03$, $p < .001$ and $t = 48.17$, $p < .001$). However, the Job Aid (JA) group performed significantly poorer on the final exam than the No-Job Aid (NJA) or the control groups ($t = 2.13$ and $t = 2.47$, $p < .05$). This finding was exactly opposite to what had been predicted. It may be that the job aid failed to enhance learning and performance because it needs to be redesigned from a human factors standpoint. Many students had trouble learning to use the job aid; rather than a help, it became a task that was required in addition to solving recipe conversion problems. In other words, in the case of the job aid CBT lesson, two new things were actually being taught: how to understand the theory of receipe conversion and how to use the job aid to actually convert a recipe. As a result, the job aid lesson contained nine objectives; and the no job aid lesson, only six. Thus, it appears that the job aid should not be introduced when a student is learning about the theory of recipe conversion. Rather, it could be introduced later as a tool for an already knowledgeable cook (just as a hand calculator would be another alternative to manually doing division/multiplication).

Table 2

Means and Standard Deviations for Training Time in Hours and School Final Test Scores in Recipe Conversion Area

	CBT-- Job Aid Group		CBT-- No Job Aid Group		Control Group	
Measures	Mean	SD	Mean	SD	Mean	SD
Time (Hours)	4.44	1.86	4.34	2.07	26.5**	0[a]
Final Score (%)	87.7*	16.28	94.4	4.92	95.5	4.75

[a]Fixed schedule for all Ss.

*p < .05
**p < .001

Student Attitude

Since the lesson strategy was based on learner control, where the initiative lies with the student, it was important to determine whether the CBT students felt comfortable making the decisions necessary to progress through the material. Thus, one of the questions in the attitude questionnaire asked the students to rate their ability to "figure out what to do next, without being told." They were to respond by using a five-point scale, ranging from "very easy" to "very difficult." Results showed that both CBT groups were comfortable with learner control. Eight members (40%) of the JA group responded with "very easy": three (15%), "easy"; and nine (45%), "somewhat easy." For the NJA group, two (10%) responded with "very easy"; ten (50%), "easy"; and six (30%), "somewhat easy." Only one NJA group member felt that learner control was "somewhat difficult," and one failed to respond.

Another question asked the students to rate computer-based training on a five-point scale ranging from "outstanding" to "poor." Again, results were positive. Sixteen members (80%) of the JA group felt that CBT was "outstanding," and four (20%), "above average." For the NJA group, twelve (60%) rated CBT as "outstanding"; and five (25%), "above average." Only one NJA group member felt that CBT was "fair," and two failed to respond.

PLATO System Reliability

Seventy-nine percent of the CBT students experienced line errors; that is, problems with the transmission of material over telephone lines. These errors appeared to the students either as overlays of two lines, which were impossible to read, or as interruptions, when the screen went blank and the student had to sign back onto the lesson. Because the instructional materials were presented under a learner control mode, the problems were especially frustrating to the CBT students. They reported that the line errors resulted in (1) interruptions in train of thought and loss of continuity, because of being sent back to the index by the learner driver, and (2) frustration and anger with the system at being forced to "pace through" several problems to get back to the point of interruption.

DISCUSSION AND CONCLUSIONS

Computer-based training (CBT) appears to be effective for the average and below average personnel in the Mess Management Specialist School. The two CBT groups completed the course in significantly less time than the control group, and the No Job Aid CBT group performed equally as well on the final examination as the control group. Although the Job Aid CBT subjects performed significantly lower on the examination than the other CBT and control groups--a finding which was unexpected--they still did well, having a mean test score of 87 percent. This suggests that low aptitude students can profit from individualization, which greatly reduces training time, and still maintain a high level of competency.

At this point, it should be noted that, concurrently with our initial survey of the MS school recipe conversion area, the school officials themselves were becoming disenchanted with the school's curriculum. Thus, for a number of reasons, our interest may have acted as a stimulus for revision of the curriculum. At the time of the initial survey, trainees in the math area were experiencing a significant failure rate (50% scored below 75 on the area final), as well as performing poorly in the lab situation (galley) which is the school's criterion measure. Accordingly, the two CBT courses were designed to fill the need for remedial math. However, by the time the CBT courses had been written and students were ready to be instructed, the MS school had revised its priorities to teach criterion-referenced skills of recipe conversion. Because of this change in emphasis that occurred in the interim between the initial survey and the completion of the CBT project, it was necessary to compare the CBT presentations with the revised classroom math procedures. As a result, performance differences may have been nullified due to improved classroom revisions.

Further, this study did not consider the scheduling problems that may be involved in instituting CBT while still having to maintain galley training, which requires 40 students simultaneously in order to fully utilize the galley facilities.

RECOMMENDATIONS

The following recommendations are made:

1. The use of the job aid should be taught separately from theory on recipe conversion. If the student is not forced to learn two new things at once, such training may result in both time savings and improved scores.

2. The CBT lesson that uses mathematical solutions should be used as a drill-and-practice remedial tool by the MS school, given the availability of PLATO or another CBT system.

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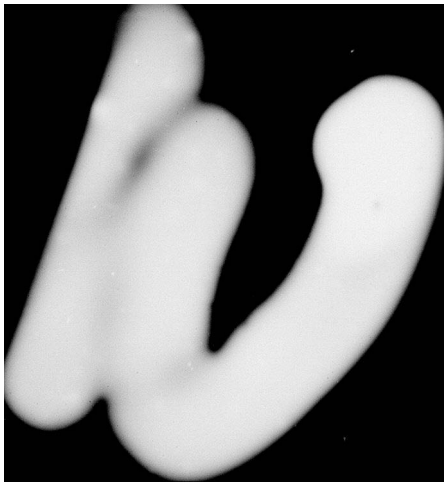

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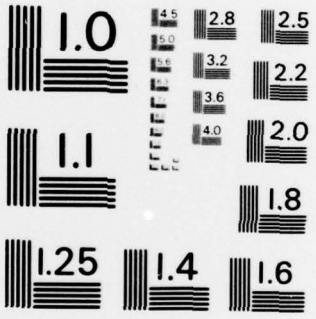

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Pages ii,vi,2,8,12 are blanks.

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